

MEPAG Recommendations for a 2018 Mars Sample Return Caching Lander – Sample Types, Number, and Sizes

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The return to Earth of geological and atmospheric samples from the surface of Mars is among the highest priority objectives of planetary science. The MEPAG Mars Sample Return (MSR) End-to-End International Science Analysis Group (MEPAG E2E-iSAG) was chartered to propose scientific objectives and priorities for returned sample science, and to map out the implications of these priorities, including for the proposed joint ESA-NASA 2018 mission that would be tasked with the crucial job of collecting and caching the samples.

The E2E-iSAG identified four overarching scientific aims that relate to understanding: (A) the potential for life and its pre-biotic context, (B) the geologic processes that have affected the martian surface, (C) planetary evolution of Mars and its atmosphere, (D) potential for future human exploration.

The types of samples deemed most likely to achieve the science objectives are, in priority order:

- 1A. Subaqueous or hydrothermal sediments
- 1B. Hydrothermally altered rocks or low temperature fluid-altered rocks (equal priority)
2. Unaltered igneous rocks
3. Regolith, including airfall dust
4. Present-day atmosphere and samples of sedimentary-igneous rocks containing ancient trapped atmosphere

Collection of geologically well-characterized sample suites would add considerable value to interpretations of all collected rocks. To achieve this, the total number of rock samples should be about 30-40.

In order to evaluate the size of individual samples required to meet the science objectives, the E2E-iSAG reviewed the analytical methods that would likely be applied to the returned samples by preliminary examination teams, for planetary protection (i.e., life detection, biohazard assessment) and, after distribution, by individual investigators. It was concluded that sample size should be sufficient to perform all high-priority analyses in triplicate. In keeping with long-established curatorial practice of extraterrestrial material, at least 40% by mass of each sample should be preserved to support future scientific investigations. Samples of 15-16 grams are considered optimal. The total mass of returned rocks, soils, blanks and standards should be approximately 500 grams. Atmospheric gas samples should be the equivalent of 50 cm³ at 20 times Mars ambient atmospheric pressure.